Investigating different populations of RR Lyrae stars with K2
Katrien Kolenberg
University of Vienna

ABSTRACT: RR Lyrae stars play a crucial role in astrophysics as standard candles, tracers of galactic history, and touchstones for modelling stellar pulsations. Space data of these crucial objects have led to a giant leap forward in our understanding of their structure and evolution, through the discovery of new dynamical phenomena. Moreover, insight into these stars   dynamics is of crucial importance to advance our knowledge of galaxy formation and evolution in the Local Group of galaxies and beyond. In this proposal we plan to study roughly 200-200 RR Lyrae stars in long cadence and 5-5 in short cadence in K2 Fields 6&7. Field 7 contains both galactic RR Lyraes and members of the Sagittarius (Sgr) dwarf galaxy (Cseresnjes 2011, A&A 375, 909), and offers a unique chance to study two distinctly different populations. Moreover, K2's unique long, uninterrupted, high-precision space photometry, allows us conduct galactic structure studies and to improve our understanding of RR Lyrae pulsation and dynamics.

RESEARCH GOALS: 1. Throughout the K2 Mission we are building up a unique database from field to field covering different parts of our Galaxy and beyond (the Sgr dwarf galaxy in Field 7). Such an unprecedented photometric RR Lyrae sample will form the base of galactic structure studies and near-field cosmology. We will study the Galactic structure and history by obtaining distances to RR Lyrae stars and determine their spatial distribution (halo streams, over-densities). 2. The samples of K2 RR Lyrae data allow for a statistical analysis of various dynamical phenomena (double-mode pulsation, Blazhko-modulation, period-doubling, low-dimensional chaos, nonradial modes) and their occurrence rates to better understand their origin and their effect on distance determination. This can only be accomplished with K2. (In the nominal Kepler mission we had around 50 RR Lyrae stars on silicon.) 3. We will perform a detailed analysis of all RR Lyrae light curves, especially overtone and classical double-mode pulsators. The original Kepler field contained no RRd stars, and only a few RRc. This will aid the investigation of dynamical phenomena (resonances, mode interactions) that may be important in other types of pulsating stars, but can be studied in detail only in large-amplitude stars and with space photometry.

METHODS: We produce light curves from target pixel data (PyKE and own software), then apply corrections, trend-filtering, outlier removal, etc. Standard time-frequency analysis (by e.g. Period04) and study of time-dependent features are envisaged. We derive metallicities from empirical relations using the light curve shapes and spectroscopic observations. State-of-the-art numerical hydrocodes (Florida-Budapest, Warsaw) will help to interpret the results. Synthetic galactic models (TRILEGAL) will be used to compare the galactic location and number of the observed sample with simulations. Targets. ~200 RR Lyrae stars will be proposed per field (5-5 for short cadence observations). Due to their distances, RR Lyrae stars are faint, the majority between 15-19 Kepler mag.

EXPERIENCE: Our team consists of members of the Working Group#7 (RR Lyrae and Cepheids) of the Kepler Asteroseismic Science Consortium, who have been working on Kepler data (also preparation and target selection) since the launch of the nominal mission. We have experts on data reduction, pixel photometry, light curve and time-frequency analysis, as well as theorists performing numerical hydrodynamical modeling. We routinely analyzed Kepler data, developed dedicated software to Kepler light curves and published 15+ Kepler RR Lyrae papers in high-impact journals. The group has access to ground-based follow-up (multi-color photometric and spectroscopic) instruments in Taiwan, Korea, the US and Hungary to complement space-based observations.